

December 8, 2004

Mr. A. Christopher Bakken, III
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SUBJECT: HOPE CREEK GENERATING STATION - IMPLEMENTATION OF A
RISK-INFORMED INSERVICE INSPECTION PROGRAM (TAC NO. MC2221)

Dear Mr. Bakken:

By letter dated March 1, 2004, as supplemented by letters dated March 11, 2004, August 17, 2004, August 20, 2004, and October 12, 2004, PSEG Nuclear, LLC (PSEG), requested Nuclear Regulatory Commission (NRC) approval of a proposed alternative to the requirements of "Rules for Inservice Inspection of Nuclear Power Plant Components," Section XI of the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code). The request was submitted pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i). The March 11, 2004, supplement identified that the March 1, 2004, letter was an internal review copy, and should be replaced, in its entirety, by the March 11, 2004, letter.

The requested alternative would allow PSEG to utilize the methodology contained in the NRC-approved Electric Power Research Institute's Topical Report 112657, Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure." The NRC staff has completed its review, and has determined that the proposed alternative will provide an acceptable alternative to the requirements of ASME Code, Section XI, for Code Class 1 and 2 piping, Examination Categories B-F, B-J, C-F-1, and C-F-2 welds. The NRC, therefore, authorizes the proposed alternative pursuant to 10 CFR 50.55a(a)(3)(i).

The basis for the NRC staff's conclusion is contained in the enclosed safety evaluation. If you have any questions, please contact Daniel Collins at (301) 415-1427.

Sincerely,

/RA/

Darrell J. Roberts, Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-354

Enclosure: Safety Evaluation

cc w/encl: See next page

Hope Creek Generating Station

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
IMPLEMENTATION OF A RISK-INFORMED INSERVICE INSPECTION PROGRAM

PSEG NUCLEAR LLC

HOPE CREEK GENERATING STATION

DOCKET NO. 50-354

1.0 INTRODUCTION

By letter dated March 1, 2004, as supplemented by letters dated March 11, 2004, August 17, 2004, August 20, 2004, and October 12, 2004, PSEG Nuclear LLC (PSEG or the licensee), proposed a risk-informed inservice inspection (RI-ISI) program as an alternative to a portion of its current inservice inspection (ISI) program for Hope Creek Generating Station (HCGS). The scope of the RI-ISI program would be limited only to the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code), Class 1 and 2 piping, Examination Categories B-F, B-J, C-F-1, and C-F-2 welds. The March 11, 2004, supplement identified that the March 1, 2004, letter was an internal review copy, and should be replaced, in its entirety, by the March 11, 2004, letter. Hereafter, the March 11, 2004, letter is referred to as the submittal and all supplements are identified by their date.

The licensee's RI-ISI program was developed in accordance with the methodology contained in the Electric Power Research Institute's (EPRI) Topical Report (TR) TR-112657, Revision B-A (the EPRI TR), which was previously reviewed and approved by the Nuclear Regulatory Commission (NRC). The safety evaluation for this approval is available in the Agencywide Documents Access and Management System¹ (ADAMS) under accession number ML993190460. The licensee proposed the RI-ISI program as an alternative to the requirements in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i). The licensee requested implementation of this alternative beginning with the third period of the second 10-year ISI interval at HCGS.

¹Note: As of the date of issuance of this safety evaluation public access to ADAMS has been temporarily suspended so that security reviews of publicly available documents may be performed and potentially sensitive information removed. Please check the NRC Web site for updates on the resumption of ADAMS access.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g), ASME Code, Class 1, 2, and 3 components (including supports) shall meet the requirements set forth in the ASME Code to the extent practical within the limitations of design, geometry, and materials of construction of the components. Section 50.55a(g) also states that the ISI of the ASME Code, Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code and applicable addenda, except where specific written relief has been granted by the NRC. The objective of the ISI program as described in Section XI of the ASME Code and applicable addenda is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary of these components that may impact plant safety.

These regulations also require that, during the first 10-year ISI interval and during subsequent intervals, the licensee's ISI program complies with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference into 10 CFR 50.55a(b) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. HCGS is in the second interval. The applicable edition of Section XI of the ASME Code for HCGS for this 10-year ISI interval is the 1989 edition with no addenda.

According to 10 CFR 50.55a(a)(3), the NRC may authorize alternatives to the requirements of 10 CFR 50.55a(g) if an applicant demonstrates that the proposed alternatives would provide an acceptable level of quality and safety, or that the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment [PRA] in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," defines the following safety principles that should be met in an acceptable RI-ISI program:

- (1) The proposed change meets current regulations unless it is explicitly related to a requested exemption.
- (2) The proposed change is consistent with the defense-in-depth philosophy.
- (3) The proposed change maintains sufficient safety margins.
- (4) When proposed changes result in an increase in risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.
- (5) The impact of the proposed change should be monitored using performance measurement strategies.

RG 1.178, "An Approach for Plant-Specific Risk-Informed Decisionmaking for Inservice Inspection of Piping," describes methods acceptable to the NRC staff for integrating insights from PRA techniques with traditional engineering analyses into ISI programs for piping, and addresses risk-informed approaches that are consistent with the basic elements identified in RG 1.174.

The licensee has proposed to use an RI-ISI program for ASME Code, Class 1 and Class 2 piping (Examination Categories B-F, B-J, C-F-1, and C-F-2 welds), as an alternative to the ASME Code, Section XI requirements. The licensee states that this proposed program was developed using RI-ISI methodology described in the EPRI TR. By letter dated

October 28, 1999, the NRC staff issued a Safety Evaluation (SE), approving the methodology described in the EPRI TR, concluding that this methodology conforms to the guidance provided in RGs 1.174 and 1.178 such that no significant risk increase should be expected from the changes to the ISI program resulting from application of the methodology. The transmittal letter for this SE, of the same date, stated that an RI-ISI program as described in the EPRI TR utilizes a sound technical approach and will provide an acceptable level of quality and safety. It also stated that, pursuant to 10 CFR 50.55a, any RI-ISI program meeting the requirements of the EPRI TR provides an acceptable alternative to the piping ISI requirements with regard to (1) the number of locations, (2) the locations of inspections, and (3) the methods of inspection.

Pursuant to 10 CFR 50.55a(a)(3)(i), the staff has reviewed and evaluated the licensee's proposed RI-ISI program based on guidance and acceptance criteria provided in the following documents:

- RGs 1.174 and 1.178
- NRC NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Chapter 3.9.8
- EPRI TR-112657
- NRC SE for EPRI TR-112657 dated October 28, 1999

3.0 TECHNICAL EVALUATION

3.1 Proposed Changes to the ISI Program

The scope of the licensee's proposed changes to its ISI program is limited to ASME Code, Class 1 and Class 2 piping welds for the following Examination Categories: B-F for pressure-retaining dissimilar metal welds in vessel nozzles, B-J for pressure-retaining welds in piping, C-F-1 for pressure-retaining welds in austenitic stainless steel or high alloy piping, and C-F-2 for pressure-retaining welds in carbon or low-alloy steel piping. PSEG has proposed to implement an RI-ISI program as an alternative to the existing ISI requirements of the ASME Code, Section XI.

Implementation of the RI-ISI program will result in the number and locations of Non-Destructive Examination (NDE) inspections based on ASME Code, Section XI requirements being replaced by the number and locations of these inspections based on the RI-ISI guidelines. Currently, the ASME Code requires, in part, that for each successive 10-year ISI interval, 100% of Category B-F welds and 25% of Category B-J welds for the ASME Code, Class 1, non-exempt piping be selected for volumetric and/or surface examination based on existing stress analyses and cumulative usage factors. For Category C-F welds in Class 2 piping, 7.5% of non-exempt welds are selected for volumetric and/or surface examination. The proposed RI-ISI program for HCGS selects 93 of 1004 Class 1 piping welds, and 11 of 1299 Class 2 piping welds for NDE. The surface examinations required by the ASME Code, Section XI, will be discontinued while system pressure tests and VT-2 visual examinations would continue. These results are consistent with the concept that, by focusing inspections on the most safety-significant welds, the number of inspections can be reduced while at the same time maintaining protection of public health and safety.

In its submittal, PSEG discussed the following augmented piping inspection programs and how they would be affected by implementation of the RI-ISI program.

Subject	Source Document	Status of Incorporation into Licensee RI-ISI Program
Feedwater Nozzle Cracking	NUREG-0619, "[Boiling Water Reactor] BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking," November 1980	In both its letters, August 17, 2004, and October 12, 2004, the licensee stated that the feedwater nozzle-to-safe-end welds selected for inspection per the RI-ISI program do not affect the augmented inspection program requirements for these locations. The existing augmented program was designed to detect thermal fatigue degradation. The purpose of the RI-ISI is to detect corrosion initiated in the crevices of the feedwater thermal sleeves.
Intergranular stress corrosion cracking (IGSCC) in BWRs	NUREG-0313, "Technical report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," January 1998; GL 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping" January 25, 1988	Section 2.2 of the submittal stated "The HCGS is incorporating the guidance contained in BWR vessel and Internals Project Report No. BWRVIP-75. BWRVIP-75 provides alternative criteria to NRC Generic Letter 88-01 for the examination of welds susceptible to intergranular stress corrosion cracking (IGSCC)." Section 2.2 further stated "As such, the examination of welds identified as Category "A" inspection locations is subsumed by the RI-ISI Program. The existing plant augmented inspection program for the other piping welds susceptible to IGSCC at the HCGS (Categories "C" and "E") remains unaffected by the RI-ISI Program submittal."
Thermal Stresses in Piping Connected to the Reactor Coolant System (RCS)	NRC Bulletin, BL 88-08, "Thermal Stress in Piping Connected to Reactor Coolant Systems" May 3, 1988	Table 6-2 of the EPRI TR states that BL 88-08-related degradation mechanisms are addressed by the evaluation of thermal fatigue and, therefore, these programs may be subsumed into the RI-ISI program. However, in its August 17, 2004, letter, the licensee stated that its review of NRC BL 88-08 concluded that no further action was required.
Service Water Integrity Program	GL 89-13, "Service Water System Problems Affecting Safety-Related Equipment," July 18, 1989	In its August 17, 2004, letter, the licensee indicated that the service water system at HCGS is within the ASME Code, Class 3 scope, and that this application is not related to the plant's augmented inspection program for GL 89-13.

Subject	Source Document	Status of Incorporation into Licensee RI-ISI Program
Flow Accelerated Corrosion (FAC)	GL 89-08, "Erosion/Corrosion-Induced Pipe Weld Thinning," May 2, 1999	Section 2.2 of the submittal states that the plant augmented inspection program for FAC per GL 89-08 is relied upon to manage this damage mechanism but is not otherwise affected or changed by the RI-ISI Program.
Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment (Note: Exam requirements apply to high energy containment penetration piping.)	Mechanical and Civil Engineering Branch Technical Position (BTP) 3-1	Section 2.2 of the submittal states "The plant augmented inspection program for break exclusion region (BER) piping welds as defined by the requirements of BTP 3-1 is not affected by the RI-ISI Program application."

The subsuming of Category A welds in GL 88-01 by the RI-ISI program is permitted by the EPRI TR, because Category A welds are considered resistant to IGSCC. Examinations associated with those augmented piping inspection programs which were not subsumed by the RI-ISI program will continue in accordance with those programs.

3.2 Engineering Analysis

In accordance with the guidance provided in RGs 1.174 and 1.178, the licensee provided the results of an engineering analysis of the proposed changes, which utilized a combination of traditional engineering analysis and supporting insights from the PRA. The licensee performed an evaluation to determine susceptibility of components to a particular degradation mechanism that may be a precursor to leak or rupture, and then performed an independent assessment of the consequence of a failure at that location. The results of this analysis are used to assure that the proposed changes are consistent with the principles of defense-in-depth contained in EPRI TR-112657. The methodology in the EPRI TR requires that the population of welds with high consequences following failure will always have some weld locations inspected regardless of the failure potential. No changes to the evaluation of design-basis accidents in the final safety analysis report are being made by the RI-ISI process, therefore, sufficient safety margins will be maintained.

3.2.1 Failure Potential

Piping systems within the scope of the RI-ISI program were divided into pipe segments. Pipe segments are defined as lengths of pipe whose failure (anywhere within the pipe segment) would lead to the same consequence and which are exposed to the same degradation mechanisms. That is, some lengths of pipe whose failure would lead to the same consequence may be split into two or more segments when two or more regions are exposed to different degradation mechanisms. The licensee's submittal stated that failure potential assessment, summarized in Table 3.3 of the submittal, was accomplished utilizing industry failure history,

plant-specific failure history, and other relevant information using the guidance provided in the EPRI TR.

Section 3 of the licensee's submittal describes a proposed deviation to the EPRI RI-ISI methodology for assessing the potential for the thermal stratification, cycling, and striping (TASCS) degradation mechanism. Per this section, as supplemented by the August 20, 2004, letter, this proposed methodology for assessing TASCS at HCGS follows the guidance in References 1 and 2.

In the proposed deviation, the licensee provided additional considerations for determining the potential for TASCS, including piping configuration and potential turbulence, low flow conditions, valve leakage, and heat transfer due to convection. The staff finds that these considerations are appropriate for determining the potential for TASCS. The licensee further stated in its August 20, 2004, submittal, that when available, it would incorporate applicable NRC-approved final guidance for determining TASCS potential into its RI-ISI program for assessing TASCS. The NRC staff finds this acceptable.

Based on the above discussion, the NRC staff concludes that the licensee has met the Standard Review Plan (SRP) Section 3.9.8 guidelines to confirm that a systematic process was used to identify the component's susceptibility to common degradation mechanisms, and to categorize these degradation mechanisms into the appropriate degradation categories with respect to their potential to result in a postulated leak or rupture.

3.2.2 Consequence Analysis

The licensee stated that the consequences of pressure boundary failures were evaluated and ranked based on their impact on core damage frequency and containment performance (isolation, bypass and large early release). The licensee notes that the consequence evaluation included an assessment of shutdown and external events. Also, the licensee indicates that impact on the above measures due to both direct and indirect effects was considered. The licensee reported no deviations from the approved consequence evaluation guidance provided in the topical. Therefore, the staff considers the consequence analysis performed by the licensee for this application acceptable.

3.2.3 Probabilistic Risk Assessment

As stated in the submittal, the licensee used an updated version of its original PRA to evaluate the consequences of pipe rupture for the RI-ISI assessment. This version of the risk model, Revision 1.3, released in October 2000, is comprised of both Level 1 and Level 2 PRA analyses, which are directly interfaced. The licensee indicates that this is the fourth revision to the model used to support the individual plant examination (IPE), incorporating one major revision followed by three minor revisions. It addresses accidents initiated by internal events at full power, including internal flooding, and containment response to these accidents. Based on Revision 1.3, the licensee states that the baseline core damage frequency (CDF) estimated from this PRA model is $8.7\text{E-}06/\text{yr}$ and the baseline large early release frequency (LERF) estimated is $1.0\text{E-}06/\text{yr}$.

The licensee included a detailed history of the HCGS PRA models in the submittal. Work on the first Level 1 PRA model preceded the issuance of GL 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities," and was completed in January 1990. As a result, the licensee's IPE submittal consisted of an updated Level 1 PRA model, combined with a new Level 2 PRA model, which was completed in late 1992. The HCGS IPE was submitted to the NRC May 31, 1994. The IPE estimated a CDF of $4.6\text{E-}05/\text{year}$. The staff's SE of the IPE, dated April 23, 1996, concluded that the licensee's IPE process was capable of identifying the most likely severe accidents and severe accident vulnerabilities and, therefore, that the HCGS IPE had met the intent of GL 88-20.

The licensee noted, in the submittal, that Revision 1.0 to the IPE model was issued in July 1999, and addressed model issues and plant changes from 1994. Subsequent minor revisions, 1.1, 1.2, and 1.3, were released in March 2000, June 2000, and October 2000, respectively. The licensee stated that another major revision (Revision 2.0) to the PRA is undergoing final review. Revision 2.0 was not used in the preparation of this submittal, but will be incorporated into the licensee's RI-ISI program via the licensee's implementation and monitoring processes.

3.2.3.1 Staff/Industry Review of the PRA

The staff noted in the SE on the licensee's IPE that the licensee addressed an identified plant vulnerability by creating procedures to deal with the loss of heating ventilation and air conditioning (HVAC) to the switchgear and/or 1E panel rooms. In so doing, the CDF associated with these events dropped by over three orders of magnitude. The NRC staff suggested that such a reduction may be overly optimistic, and recommended that the licensee re-examine the analysis to verify the calculated CDFs. In its October 12, 2004, letter, PSEG explained that the procedure for mitigating the impact of a loss of HVAC to the switchgear and/or 1E panel rooms is modeled using four human error basic events. Of the four, two were assigned conservative screening values of 0.1 (which was sufficient to meet the GL 88-20 closure guidelines), while the other two were assigned human error probabilities (HEPs) that may be considered optimistic. These human error basic events are used to model the loss of HVAC both as an initiating event and as a support system involved with other initiating events in the HCGS PRA.

The licensee demonstrated that the impact of the potentially optimistic values of the latter two HEPs is not significant to this application (i.e., that correcting these HEPs with less optimistic values is unlikely to change the consequence ranking of pipe segments). The consequence analysis was performed using the methods described in Sections 3.3.3.2 and 3.3.3.3 of the EPRI TR (i.e., actual calculation using the PRA and use of the guidelines tables for assigning consequence categories). For pipe segments whose failure resulted only in an initiating event, conditional core damage probability (CCDP), and conditional large early release probability (CLERP) for the identified initiating events were calculated from the PRA. The licensee performed a sensitivity analysis by increasing the HEP values of the two potentially optimistic human error basic events by an order of magnitude, and then re-calculating CCDP and CLERP for these initiating events. Results show very little change in calculated CCDPs and CLERPs. None of the low-to-medium consequence, or medium-to-high consequence thresholds were crossed due to CCDP/CLERP recalculations with these elevated HEPs.

For those pipe segments whose failures either 1) impair the mitigating capability of RI-ISI

in-scope systems, or 2) have the combined effect of this and also cause an initiating event, the licensee used the above noted guidelines tables for assigning consequence categories. These tables were developed from generic data, and as such, the assumed HEPs have no influence on the consequence rankings of these pipe segments. Hence, the correction of the noted HCGS IPE weakness in the current PRA model will not change the consequence rankings of any of these pipe segments.

Based on the above, the staff concurs that this evaluation demonstrates the insensitivity of the HCGS RI-ISI program to the staff's perceived weakness in the HCGS IPE.

The licensee states that a pilot peer review of the IPE took place in November 1996, and that Revision 1.0 incorporated the most significant findings of that review. In August 1999 (after the issuance of Revision 1.0) a formal industry peer review occurred. The results of this review, "BWROG HCGS Probabilistic Safety Analysis [PSA] Certification," were issued in November 1999. The high-level results are summarized as follows:

- The PSA can effectively be used to support applications.
- The Hope Creek PSA Peer Review Certification has examined the key elements of the Hope Creek internal events Level 1 and Level 2 PSA and has found that:
 - The scope of the PSA supports PSA applications through Grade 3.
 - The level of detail provided in the PSA model is sufficient to support PSA applications through Grade 3.
 - The documentation of the PSA could be enhanced to ensure it supports PSA applications greater than Grade 2 in the future.
 - The PSA is supportive of Grade 2 and higher applications in all areas, and in many areas fully supportive of Grade 3 applications.

The licensee also noted that the main comments in the above review were connected with the treatment of:

- Level 2 LERF sequence timing.
- Human action dependencies.

In its submittal the licensee concluded that neither of these issues would impact the consequence rankings because the risk importance of the systems evaluated in the RI-ISI process is dominated by loss-of-coolant accident (LOCA) events. The staff agrees with this conclusion for the LERF sequence timing issue on the basis that the correction of this issue would likely not result in any change to base CDF, and little, if any, change to base LERF itself. Hence, no changes to pipe segment CCDPs, or meaningful changes to pipe segment CLERPs are expected.

In its August 17, 2004, letter the licensee indicated that the peer review recommendation on human action dependencies has been implemented. However, following a review of the implementation of this recommendation in the current model (Revision 1.3) the licensee identified that one of the corrections had not been implemented. This recommendation was to update a pre-initiator dependency with the miscalibration of a pair of in-series temperature control valves in the safety auxiliaries control system (SACS). The licensee stated that:

- If either of the two valves is miscalibrated and fails, the affected SACS loop will fail.
- The dependency is currently modeled as a common-cause failure CCF input into the failure of both valves.
- The impact of these CCF inputs on CDF is negligible.
- To correct this requires the removal of these CCF inputs.

The staff concurs with this impact evaluation, in that updating these inputs is not likely to elevate the consequence ranking of any pipe segment.

Therefore, the staff concludes that all significant comments from the IPE review and from the two industry peer reviews of the licensee's PRA have either been corrected with the issuance of the current PRA model, Revision 1.3, or that the licensee has adequately demonstrated that unaddressed issues would have no significant impact upon the RI-ISI application. The staff did not review these PRA models to assess the accuracy of the quantitative estimates, and their ability to support this application. The staff recognizes that the quantitative results of the PRA model are used as order of magnitude estimates to support the assignment of segments into three broad consequence categories. Inaccuracies in the models or in assumptions large enough to invalidate the broad categorizations developed to support the RI-ISI should have been identified during the staff's review of the IPE, and by the licensee's model update and control program that include industry peer review/certification of the PRA model. Minor errors or inappropriate assumptions will affect only the consequence categorization of a few segments and will not invalidate the general results or conclusions.

3.2.3.2 Change in Risk

As required by Section 3.7 of the EPRI TR, the licensee evaluated the change in risk expected from replacing the current ISI program with the RI-ISI program. The calculations estimated the change in risk due to removing locations and adding locations to the inspection program.

The expected change in risk was quantitatively evaluated using the "Simplified Risk Quantification Method" described in Section 3.7 of the EPRI TR. For high consequence category segments, the licensee used the conditional core damage probability (CCDP) and conditional large early release probability (CLERP) based on the highest estimated CCDP and CLERP. For medium consequence category segments, bounding estimates of CCDP and CLERP were used. The licensee estimated the change in risk using bounding pipe failure rates from the EPRI methodology.

The licensee performed its bounding analysis with and without taking credit for an increased probability of detection (POD). In its August 17, 2004, letter, the licensee provided the equation used for calculating delta risk, and the POD values assumed for various degradation mechanisms for an ASME Code, Section XI program NDE or for an RI-ISI program NDE. The equation used and the assumed POD values are consistent with the approved methodology and prior approved submittals, and is, therefore, acceptable.

The aggregate change in risk estimates are provided in the following table.

Change in CDF		Change in LERF	
With Increased POD	Without Increased POD	With Increased POD	Without Increased POD
1.21E-09/yr	3.45E-09/yr	1.21E-10/yr	3.45E-10/yr

The staff finds the licensee's process to evaluate and bound the potential change in risk reasonable because it 1) accounts for the change in the number and location of elements inspected, 2) recognizes the differences in degradation mechanisms related to failure likelihood, and 3) considers the synergistic effects of multiple degradation mechanisms within the same pipe segment. System level and aggregate estimates of the changes in CDF and LERF are less than the corresponding guideline values in the EPRI TR. The staff finds that re-distributing the welds to be inspected with consideration of the safety significance of the segments provides assurance that segments whose failure have a significant impact on plant risk receive an acceptable and often improved level of inspection. Therefore, the staff concludes that the implementation of the RI-ISI program, as described in the licensee's submittal, will have a small impact on risk consistent with the guidelines of RG 1.174.

3.2.4 Integrated Decisionmaking

The licensee used an integrated approach in defining the proposed RI-ISI program by considering in concert the traditional engineering analysis, the risk evaluation, the implementation of the RI-ISI program, and performance monitoring of piping degradation. The NRC staff finds this to be consistent with the guidelines given in RG 1.178, and, therefore, acceptable.

3.2.4.1 Risk Characterization

The licensee states that pipe segments (and ultimately the elements within, which are defined as all having the same degradation susceptibility) are ranked in accordance with definitions given in the EPRI TR. Therefore, the NRC staff finds the licensee's pipe segment ranking acceptable.

3.2.4.2 Selection of Element Population for Inspection

The process of selecting pipe elements to be inspected is described in Section 3.5 of the licensee's submittal.

In its August 20, 2004, letter, PSEG provided additional details for elements susceptible to FAC or IGSCC degradation mechanisms as follows:

For elements susceptible to FAC and any other degradation mechanisms, the licensee indicated that an NDE for FAC would not adequately detect other degradation mechanisms identified by the RI-ISI program. Hence, no FAC examinations will be credited to satisfy RI-ISI selection requirements. Rather, inspection locations selected for RI-ISI purposes that are in the FAC program will be subjected to an independent examination to satisfy the RI-ISI program requirements.

The licensee selected, under the RI-ISI program, six elements at HCGS susceptible to the non-category A IGSCC degradation mechanism, and credited the NDE for IGSCC, as specified by

this augmented inspection program, as an RI-ISI program NDE. The licensee stated in Table 3.6-1 of the submittal that NDEs of these welds were previously credited in the ASME Code, Section XI, ISI program.

In its August 20, 2004, letter, the licensee stated that there are 20 elements within the RI-ISI program scope (and counted as part of the overall RI-ISI weld population) that are also in the scope of the non-Category A IGSCC program. Of these 20, 13 of them contain other degradation mechanisms and 7 of them contain only IGSCC. Of the 13 that have other degradation mechanisms, 4 of them were previously selected for NDE under the IGSCC program, and are proposed for credit in the RI-ISI program. Of these four, 3 are considered susceptible to IGSCC in crevice locations, and one to thermal fatigue. Of the 7 that have no other degradation mechanisms, 2 were previously selected for NDE under the IGSCC program, and are proposed for credit in the RI-ISI program. The licensee noted that of the 14 welds not selected for NDE under the RI-ISI program, none is currently selected for NDE under the IGSCC program. In summary, the licensee has proposed to credit all six NDEs currently performed for the IGSCC program toward the RI-ISI program NDE count.

In its submittal, the licensee stated that the selection of elements to be examined was determined using the guidance provided in the EPRI TR, specifically taking note of Section 3.6.4.2 "ASME Code Case N-578". The staff believes that this process of taking credit for augmented inspection program NDEs is more consistent with the provisions of Code Case N-560 (which explicitly permits such crediting), than with Code Case N-578, as they are described in the topical. Because the provisions of both Code Cases within the topical were approved, the staff considers the use of this provision of Code Case N-560 (the crediting of augmented inspection program NDEs) along with the other provisions of Code Case N-578 acceptable.

The licensee provided detailed information on the results of the evaluation in the following tables included in its submittal:

- Table 3.1 provides the number of segments and elements associated with each system in the ASME Code, Class 1 and 2 scope.
- Table 3.4 identifies, on a per-system basis, the number of segments, by risk category, from both perspectives of including and excluding FAC/IGSCC as RI-ISI degradation mechanisms.
- Table 3.5 provides, from the perspective of excluding FAC/IGSCC as a RI-ISI degradation mechanism, a listing of the number of elements, by system, in each category, as well as the number of locations selected for NDE.
- Table 3.6-1 provides the risk impact analysis results for each element grouping by system, consequence rank, and combination of damage mechanisms.
- Tables 5.1 and 5.2 provide summaries comparing the number of inspections required under the 1989 ASME Code, Section XI, ISI program with the alternative RI-ISI program by ASME Code, Section XI weld groupings and by RI-ISI weld groupings, respectively.

The licensee stated that 9.3% of Class 1 piping welds were selected for RI-ISI NDEs. Section 3.6.4.2 of the EPRI TR states that if the percentage of Class 1 piping locations selected for examination falls substantially below 10%, then the basis for selection needs to be investigated. The licensee provided the following information relative to having fewer than 10% of Class I welds selected for NDE:

- The sampling percentage for Class 1 piping locations includes both socket and non-socket welds. If only non-socket welds are considered, the percentage of Class 1 piping welds selected for examination increases to 12%.
- No FAC examinations are being credited to satisfy RI-ISI selection requirements. Hence, the above sampling percentage does not take credit for any inspection locations selected for examination per the plant's augmented inspection program for FAC beyond those selected per the RI-ISI process, which will be subjected to an independent examination to satisfy the RI-ISI program requirements.
- All of the non-Category A inspection locations selected for examination per the plant's augmented inspection program for IGSCC (five Category C and one Category E) were also selected as RI-ISI locations either due to the presence of other damage mechanisms, or to satisfy risk Category 4 selection requirements.

With regard to having only 9.3% of the total ASME Code, Class 1 welds selected for NDE, instead of 10% or more, the staff finds the licensee's evaluation reasonable and acceptable.

Based on the staff's review of the above tables (containing the results of element selection) the NRC staff concludes that the element selection results are consistent with the described process, and with EPRI TR-112657 guidelines. Hence, the licensee's selection of element locations, which includes consideration of degradation mechanisms in addition to those covered by augmented inspection programs, is acceptable.

3.2.4.3 Examination Methods

As noted previously, the objective of ISI is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary that may impact plant safety. To meet this objective, the risk-informed location selection process, per the EPRI TR, employs an "inspection for cause" approach. To address this approach, Section 4 of the EPRI TR provides guidelines for the areas and/or volumes to be inspected, as well as the examination method, acceptance standard, and evaluation standard for each degradation mechanism. The licensee stated that Section 4 of the EPRI TR was used as guidance in determining the examination methods and requirements for these locations. Based on its review and acceptance of the EPRI TR, the staff concludes that these examination methods are appropriate since they are selected based on specific degradation mechanisms, pipe sizes, and materials of concern.

Given these considerations, the licensee's determination of examination methods is considered acceptable.

3.2.4.4 Relief Requests for Examination Locations and Methods

As required by Section 6.4 of the EPRI TR, the licensee has completed an evaluation of existing relief requests to determine if any should be withdrawn or modified due to changes that occur from implementing the RI-ISI program. The licensee concludes that none of its existing relief requests should be modified or withdrawn as a result of the RI-ISI application.

The licensee further stated that, for any examination location where greater than 90% volumetric coverage cannot be obtained, the process outlined in the EPRI TR will be followed.

The staff finds the licensee's proposal regarding relief requests acceptable.

3.2.5 Implementation and Monitoring

Implementation and performance monitoring strategies require careful consideration by the licensee and are addressed in Element 3 of RG 1.178 and SRP 3.9.8. The objective of Element 3 is to assess performance of the affected piping systems under the proposed RI-ISI program by utilizing monitoring strategies that confirm the assumptions and analyses used in the development of the RI-ISI program. Pursuant to 10 CFR 50.55a(a)(3)(i), a proposed alternative, in this case the implementation of the RI-ISI program, including inspection scope, examination methods, and methods of evaluation of examination results, must provide an acceptable level of quality and safety.

The licensee stated that upon approval of the RI-ISI program, procedures that comply with EPRI TR-112657 guidelines will be prepared to implement and monitor the RI-ISI program. The licensee confirms that the applicable aspects of the ASME Code not affected by the proposed RI-ISI program would be retained.

The licensee identified in Section 4 of its submittal that the RI-ISI program is a living program and its implementation will require feedback of new relevant information to ensure the appropriate identification of safety significant piping locations. The licensee also stated that, as a minimum, risk ranking of pipe segments will be reviewed and adjusted on an ASME Code-period basis, that significant changes may require more frequent adjustment as appropriate per NRC generic communications, or by industry and plant-specific feedback. This periodic review and adjustment of the risk-ranking of segments ensures that changes embodied in Revision 2.0 to the HCGS PRA that could affect the RI-ISI program will be systematically incorporated as needed.

The licensee addressed additional examinations in Section 3.5.1 of its submittal, which stated that examinations performed that reveal flaws or relevant conditions exceeding the applicable acceptance standards shall be extended to include additional examinations. These additional examinations shall include piping structural elements with the same postulated failure mode and the same or higher failure potential. Additional examinations will be performed on these elements up to a number equivalent to the number of elements with the same postulated failure mode originally scheduled for that fuel cycle. If the additional required examinations reveal flaws or relevant conditions exceeding the acceptance standards, the examinations shall be further extended to include all elements subject to the same failure mechanism, throughout the scope of the program, during the same outage.

The staff finds the licensee's approach acceptable since the additional examinations, if required, will be performed during the outage that the indications or relevant conditions are identified.

HCGS has completed the second period of the second 10-year ISI inspection interval, and is planning to complete all of the program activities of the second interval during the third period, commencing with its scheduled refueling outage RFO12, in the fall of 2004. The HCGS RI-ISI program will be integrated into the second interval. The licensee will take credit for ASME Code, Section XI, ISI inspections performed during the first two periods of the second 10-year ISI interval. During these periods, 64.3% of the ASME Code, Section XI examinations have

been completed. To meet the ASME Code, Section XI requirements, the licensee will examine 35.7% of locations selected for RI-ISI during the third period. The staff finds this acceptable because it is consistent with the guidance provided in the SE approving EPRI TR-112657, Rev. B. The staff's guidance in the referenced SE stated, in part, that the implementation of the RI-ISI program at any time within an inspection interval is acceptable as long as the examination schedules are consistent with the interval requirements contained in Article IWB-2000 of ASME Code, Section XI as applied to Inspection Program B.

The NRC staff, therefore, finds that the proposed process for the RI-ISI program implementation, monitoring, feedback, and update meets the guidelines of RG 1.174 which states that risk-informed applications should include performance monitoring and feedback provisions. Hence, the licensee's proposed process for program implementation, monitoring, feedback, and update is acceptable.

6.0 CONCLUSION

Pursuant to 10 CFR 50.55a(a)(3)(i), alternatives to the requirements of 10 CFR 50.55a(g) may be used, when authorized by the NRC, if the licensee demonstrates that the proposed alternatives will provide an acceptable level of quality and safety. In this case, the licensee, PSEG Nuclear LLC, has proposed an alternative to use the risk-informed process described in NRC-approved EPRI TR-112657.

RG 1.174 provides guidance for risk-informed decisions involving a change to a plant's licensing basis. RG 1.178 provides guidance for risk-informed decisions involving alternatives to the requirements of 10 CFR 50.55a(g) (ISI program requirements), and its directive to follow the requirements of ASME Code, Section XI. These two RGs, taken together, define the elements of an integrated decision-making process that assesses the level of quality and safety embodied in a proposed change to the ISI program. EPRI TR-112657

RI-ISI methodology contains the necessary details for implementing this process. This methodology provides for a systematic identification of safety-significant pipe segments, for a determination of where inspections should occur within these segments (i.e., identification of locations), and for a determination how these locations will be inspected. Such segments/locations are characterized as having active degradation mechanisms, and/or whose failure would be expected to result in a significant challenge to safety (either immediately by initiating an event or later on in response to an unrelated event).

EPRI TR-112657 methodology also provides for implementation and performance monitoring strategies to insure a proper transition from the current ISI program, and to assure that changes

in plant performance and new information from the industry and/or from the NRC is incorporated into the licensee's ISI program as needed.

Other aspects of the licensee's ISI program, such as system pressure tests and visual examination of piping structural elements will continue to be performed on all Class 1, 2, and 3 systems in accordance with ASME Code, Section XI. This provides a measure of continued monitoring of areas that are being eliminated from the NDE portion of the ISI program. As required by EPRI TR-112657 methodology, the existing ASME Code performance measurement strategies will remain in place. In addition, EPRI TR-112657 methodology provides for increased inspection volumes for those locations that are included in the NDE

portion of the program.

The licensee proposed one deviation from this methodology in that it will assess susceptibility of piping segments and elements at HCGS to TASCs in accordance with the guidance in References 1 and 2. The staff finds that the considerations in these references are appropriate for determining the potential for TASCs. The staff also finds the licensee's commitment to incorporate the applicable NRC-approved final materials reliability program guidance into its RI-ISI application acceptable. Therefore, the staff concludes that the licensee's development of its RI-ISI program is consistent with the methodology described in EPRI TR-112657, Rev. B-A.

The NRC staff concludes that the licensee's proposed program which is consistent with the methodology as described in EPRI TR-112657, Rev. B-A, with one acceptable deviation, will provide an acceptable level of quality and safety for the proposed alternative to the piping ISI requirements with regard to (1) the number of locations, (2) the locations of inspections, and (3) the methods of inspection. Therefore, the proposed RI-ISI program is authorized for the remainder of the second 10-year ISI interval pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that this alternative will provide an acceptable level of quality and safety.

7.0 REFERENCES

1. P.J. O'Regan, EPRI, letter to B. Sheron, NRC, February 28, 2001
2. P.J. O'Regan, EPRI, letter to B. Sheron, NRC, March 28, 2001

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